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(54) Title: TREATMENT OF WASTE ANIMAL MATERIALS			
(57) Abstract			
<p>A method of treating waste animal materials comprises introducing the materials, preferably in comminuted form, into a vat (30), adding fly larvae, replenishing the waste materials as they are consumed by the larvae, adding fresh larvae when the existing larvae are mature, and repeating these steps until the vat is full. The remaining material, typically including bone and feathers, is then removed from the vat as a solid block, which can be broken up, dried and ground to particulate form for use as a fertilizer. A vat (30) with grooved inclined walls is preferably used, the mature larvae being thereby induced to migrate up the grooves for collection, leaving the newly-introduced larvae to consume the material in the vat.</p>			

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TREATMENT OF WASTE ANIMAL MATERIALS

This invention relates to a method of treating waste animal material, for example animal carcasses and parts 5 thereof unfit for human consumption, and to a method of making a fertilizer material, and to apparatus suitable for use in such methods.

Present methods of disposal of animal carcasses involve heat treatment, with an end product being bone meal usable, 10 for example, as fertilizer. Such processes consume considerable quantities of energy, and are therefore costly to run.

The present invention provides a method in which fly larvae or maggots are used to remove meat and fat from the 15 bones, as in nature, but without the resultant production of large numbers of flies.

In the breeding of maggots for bait for anglers, animal remains are spread over the floor of a vat, and young maggots are introduced and allowed to feed on the animal 20 remains until they are of the required size, when they are removed. However, for health reasons, there are reservations over the type of animal remains which may be used for maggot breeding. Additionally, the demand for angling bait is confined to a relatively short season.

25 According to one aspect of the invention, a method of treating waste animal material comprises the steps of:

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- a) introducing into a vat a layer of the animal material and a quantity of fly larvae;
- b) at repeated intervals sufficient for the larvae to consume substantially all of the edible matter in the animal material, introducing into the vat a fresh layer of the animal material;
- c) at repeated intervals less than or equal to the time taken for freshly introduced larvae to mature, adding a fresh quantity of new larvae; and
- 10 d) when the vat is full, and substantially all the edible material therein has been consumed by the larvae, removing from the vat the material remaining therein.

The waste animal material suitably includes animal, bird and fish carcasses and parts thereof. Bones, hide, 15 scales and feathers may also be included. Bird and other eggs, shellfish and other molluscs, and insects' remains may also be included.

The invention also provides a method of making a fertilizer material from waste animal material, comprising 20 the steps of:

- a) introducing into a vat a layer of the animal material and a quantity of fly larvae;
- b) at repeated intervals sufficient for the larvae to consume substantially all of the edible matter in the animal material, introducing into the vat a fresh layer of the animal material;

c) at repeated intervals less than or equal to the time taken for freshly introduced larvae to mature, adding a fresh quantity of new larvae;

5 d) when the vat is full, and substantially all the edible matter therein has been consumed by the larvae, removing from the vat the material remaining therein; and
e) drying the removed material.

10 Preferably, the waste animal material is first comminuted, most preferably down to a particle size of about 20mm or less. Liquid, for example blood, may then be added to produce a slurry which may be sprayed into the vats, to form layers of a thickness of about 15mm, for example.

15 After removing the remaining material in the vat the process may be repeated. The material, which may be in a compacted block form, may be broken up and then ground to form a material suitable, after drying and sterilisation, for fertilizer use.

20 It has been found that, by the addition of new larvae before or when the existing larvae mature, the new larvae will also consume the pupating larvae, thus keeping the number of larvae in the vat approximately constant. Heat is generated in the remaining material after the action of the larvae, by bacterial action, and this heat serves to promote composting of the material and to drive the larvae upwards so that, when the vat is full, they may simply be
25 upwards so that, when the vat is full, they may simply be

removed from the top, for example after covering with a heavy vinyl sheet, which results in suffocation of the larvae.

5 The larvae are mature when they are ready to pupate, as indicated for example by migration to the sidewalls of the vat, or when they begin to pupate.

10 In one method in accordance with the invention, the larvae at the side walls are removed from the vat when the numbers build up, for example by application of a vacuum pipe, and can then be collected for use as angling bait or for processing for fertilizer use. This leaves the new 15 larvae to work on the added animal remains.

Any flesh eating fly larvae may be used, for example those of the bluebottle (*Calliphora vomitoria*), the 15 greenbottle (*Lucilia Caesar*), or the so-called "black fly", a fly common in continental Europe, especially southern Europe, and commonly used in the UK in the production of angling bait.

20 Another aspect of the invention provides apparatus for treating waste animal material, comprising a vat into which the animal material and fly larvae may be introduced, the vat having at least one outwardly sloping wall provided with a plurality of grooves in the surface thereof, the 25 grooves extending from the floor of the vat to the uppermost edge of the wall, the base of each groove being inclined to the horizontal at an angle such that mature larvae are

induced to ascend the grooves, and means for collecting the larvae arriving at the uppermost edge of the wall. The angle is preferably less than 45°, more preferably about 35°.

5 Preferably, the vat is in the form of a channel wherein two opposed channel walls are the said outwardly sloping walls. A floor may extend between the two sloping walls of the channel.

The means for collecting the mature larvae may comprise
10 a collection channel extending along the length of the or each sloping wall, such that larvae arriving at the uppermost edge of the wall drop into the collection channel, the or each collection channel having at least one collection pit therein, the floor of the channel inclining upwardly towards
15 the mouth of the pit such that the larvae dropping into the collection channel are induced to move themselves upwardly along the floor and into the pit. Suction means may be provided for extracting the larvae from the or each collection pit and for delivering the larvae to further processing
20 means. This may be thermal sterilisation apparatus, for example a drying oven, which kills the larvae, or a packing station to pack the larvae for sale as angling bait, for example. Thus, the output of larvae may be switched to the appropriate further processing according to whether or not
25 there is a demand for bait.

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An additional by-product of the method is nitrogenous gas containing ammonia and various amines. The amines give rise to objectionable smells and the gases are suitably treated in a biological bed wherein they are passed, via 5 buried porous pipes, upwardly through a bed including bacteria bearing soil growing plants. Conveniently, glass-houses may be constructed over the beds, for example using the support structure of the gas distribution system as foundations for the glass-house structure.

10 Optionally, materials capable of absorbing ammonia and amines can be added to the vats at intervals. These serve the dual function of reducing the gases to be removed by the biological bed and increasing the nitrogen content of the final material for fertilizer use. Examples of such 15 materials are chopped straw, paper, cardboard, fuller's earth, particulate zeolites, comminuted brick rubble, comminuted shells, and mixtures of these.

These materials also serve to add bulk to the resultant fertilizer material, but if required, bulking materials, 20 for example sand, may also be added.

Additionally, bulking materials such as paper and straw may be added to the material removed from the vat in the final stages of the process, for example before drying and sterilisation treatment.

The larvae introduced are preferably newly emerged, since in the conditions of the vat, they will typically reach maturity within about 2 days from emergence.

5 The method of the invention will be further described with reference to the drawings, which show examples of apparatus according to alternative embodiments of the invention. In the drawings:

10 Figure 1 is a diagrammatic plan view of apparatus suitable for use in a method according to one aspect of the invention;

Figure 2 is a sectional elevation of one of the vats forming part of the apparatus shown in Figure 1;

15 Figure 3 is a diagrammatic perspective view of a part of the apparatus according to a preferred embodiment of the invention;

Figure 4 is an enlarged perspective view of a portion of the apparatus illustrated in Figure 3; and

Figure 5 is a diagrammatic plan view of apparatus according to a preferred embodiment of the invention.

20 Referring to Figures 1 and 2, the plant typically consists of a plurality of vats 1 each approximately an 8ft (2.4m) cube arranged in a rows with walk-ways 2 therebetween. At one end of the rows is located a receiving hopper 3 into which the animal remains are tipped upon arrival at the 25 plant, and which contains an auger (not shown) feeding the material into a breaker 4 which serves to comminute the

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material to produce particle sizes of about 10 - 20mm. Waste liquids such as blood may be added to provide a pumpable mixture which is then distributed by a pump 5 through piping 6 between adjacent pairs of rows of the vats 1 with a pipe 5 7 branching off between each pair of vats to permit doses of the material to be sprayed selectively into the vats at the desired intervals.

A vacuum system is optionally provided to permit removal from the vats at intervals the mature larvae which 10 have migrated to the sides of the vats. The system consists of a pump 10 connected by pipework 11 to a flexible pipe 12 adjacent to each of the vats, and by pipework 13 and a valve 14 to the inlet to a drier 15 or to outlet 16 for treatment of the collected larvae for use as bait. A second breaker 15 17 is also provided for receiving and comminuting the blocks of material from the vats 1. The material from the breaker 17 is fed to the drier 15 for drying and sterilizing by heat treatment to destroy any residual bacteria in the material.

Another optional pipework system may also be provided 20 to supply to each vat regular doses of a particulate zeolite material which has a high absorbency of ammonia and amines. This system comprises, for example, an elevated hopper 18 containing a supply of the zeolite, and pipes 19 having control outlets 20 over each vat through which predetermined 25 doses of the material can be released into the vat according to a timed sequence, or to measurements of the ammonia and/or

amine content of the gases given off by the vat. The concentrations of these gases can thus be kept within predetermined limits. The zeolite material may be a naturally-occurring clay having a high amine and ammonia absorbency, and is preferably in the form of small pellets, for example having a maximum size of about 5mm. The ammonia concentration in the gases can be reduced by approximately 35%, while the nitrogen content of the final material used for fertilizer can be increased substantially.

Referring now to Figure 2, each vat contains a steel cage 8 having a hinged bottom panel 8a and tapering inwardly towards the top to facilitate removal of material by opening of the bottom panel 8a. The corners of the cage top are each provided with an eye 9 for attachment of lifting cables permitting the cage to be removed from the vat when full. The optional flexible pipe 12 may be extended to reach around the edges of the vat to permit extraction of accumulated mature larvae at the edges of the vat.

In use, a layer of the material approximately 15mm thick is sprayed into the bottom of the vat and two cupfuls of freshly-emerged larvae or maggots are introduced. At intervals timed to coincide with approaching exhaustion of edible matter in the vat, an additional layer of the material is sprayed in.

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When the maggots are mature, as indicated, for example, by their migration to the walls of the vat, a new charge of newly-emerged maggots is introduced and the regular spraying of material is continued. When the vat is full, typically 5 in about 2 to 3 weeks from commencement of the process, the remaining maggots, now at the uppermost surface of the material, are either killed off by suffocation using a vinyl sheet, as hereinbefore described, or are removed for use as angling bait, and the pipe and nozzle 7 are swung clear. 10 The cage is then hoisted out and removed. The bottom panel 8a is swung downwardly to allow the accumulated material to drop out of the cage, so that the cage can then be returned to the vat and the process recommenced.

The consolidated block of material produced, consisting of material excreted by the larvae, together with the inedible materials such as bone and feathers, is then broken up and dried in the drier 14, with a final period at elevated temperature >121°C of sufficient duration to kill off any residual harmful bacteria. The resultant material 20 is then ground to a fine particulate consistency for application to soil as a fertilizer. Analysis of a typical sample produced without the addition of the zeolite material is as follows:-

	Dry matter	97.0 %
25	Phosphate P ₂ O ₅	6.52 %
	Potash K ₂ O	1.01 %

Nitrogen 5.77 %

pH 5.4

Ammonium NH₄⁺ 2343 mg/kg

Although Figure 1 shows an arrangement with 16 vats,
5 it will be appreciated that a larger or smaller number of
vats may be grouped together as required. The vats may be
emptied in sequence so that the minimum of plant is required
for breaking and grinding the resultant material.

A preferred apparatus in accordance with the invention
10 is illustrated in Figures 3 to 5. This consists of a series
of elongate vats 30, which may be temporarily partitioned
to form individual vats of shorter length. Each vat 30 is
in the form of a channel having a generally horizontal floor
31 and two opposed side walls 32 sloping outwardly from the
15 floor 31 at an oblique angle to the horizontal such that
mature larvae are induced to ascend the walls 32. An angle
of approximately 35° to the horizontal is suitable. Each
side wall 32 is provided with a series of grooves 33 extending
from the floor 31 to the uppermost edge of the wall. These
20 grooves 33 are shown in enlarged form in Figure 4 and are
typically of rectangular form with a width of about 5mm and
a similar depth. The grooves 33 have been found to encourage
the mature larvae to ascend the side walls 32.

Alongside each wall 32 is provided a collection channel
25 34 into which mature larvae, arriving at the uppermost edge
of the wall 32, drop. Each channel 34 is provided with a

floor 35 which ascends at an angle sufficient to induce the larvae to move upwardly along the floor, but not so steep as to make movement in that direction difficult. At intervals along the channel 34 a collection pit 36 is formed, the 5 floor 35 sloping upwardly towards each pit from a low point mid-way between two of the pits. The larvae ascending the floor 35 fall into the pits 36, from which they can be collected, for example by a suction pipe, as described hereinafter with reference to Figure 5.

10 Figure 5 shows how a typical plant embodying the apparatus and method of this aspect of the invention might be laid out. A series of, for example six vats 30 of the form shown in Figure 3, are arranged parallel to one another, with collection channels 34 between each adjacent pair of 15 vats and alongside the outermost vats. Each channel 34 is provided with collection pits 36, as described. Waste animal material is introduced via an input hopper 50 to a grinder 51, liquid such as blood being added to form a slurry which a pump 52 can distribute via a pipe network 53 to electronically or manually-controlled spray nozzle outlets 54 20 at intervals over the vats.

25 Electronic control systems employing electrical-
ly-operated valves opened in sequence are well-known to those skilled in the field of liquid and slurry handling and need not be described here in detail. Such systems would permit regular dosing of slurry into the vats in

predetermined amounts and at predetermined intervals. Materials such as chopped straw and paper, as hereinbefore described, can be added with the slurry.

5 Fresh larvae are introduced into the vats manually at intervals, or by a pneumatic or other automatic dosing system. The vats 30 may be sub-divided by removable transverse partitions 55.

10 The plant is suitably housed in a closed building provided with gas extraction and purification apparatus, which is not shown in the Figure, being conventional for maggot-breeding plant, for example.

15 A series of conveyor belts 56 and 57 are provided to receive material expelled from the full vats 30 at the end of the process. The material may be expelled by, for example, a suitable shaped blade driven along the vat with the partitions 55 (if used) removed. The conveyor belts 56 and 57 transfer the material to a grinder 58 feeding a rotary drying and sterilising oven 59. The oven 59 operates to process batches of the material, for example tumbling the 20 material in a hot gas stream, suitably produced by an oil burner, at a temperature and for a duration sufficient to reduce the moisture content and destroy harmful bacteria, such as the salmonella and staphylococcus bacteria. The resulting material can be used as a fertilizer material.

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Mature larvae are collected from the collection pits
36 by a vacuum system 60 which included a selector valve 61
to deliver the larvae either to the oven 59 or to an outlet
62 for packing for bait.

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CLAIMS

1. A method of treating waste animal material, comprising the steps of:

5 a) introducing into a vat a layer of the animal material and a quantity of fly larvae;

b) at repeated intervals sufficient for the larvae to consume substantially all of the edible matter in the animal material, introducing into the vat a fresh layer of the animal material;

10 c) at repeated intervals less than or equal to the time taken for freshly introduced larvae to mature, adding a fresh quantity of new larvae; and

d) when the vat is full, and substantially all the edible matter therein has been consumed by the larvae, 15 removing from the vat the material remaining therein.

2. A method of making a fertilizer material from waste animal material, comprising the steps of:

a) introducing into a vat a layer of the animal material and a quantity of fly larvae;

20 b) at repeated intervals sufficient for the larvae to consume substantially all of the edible matter in the animal material, introducing into the vat a fresh layer of the animal material;

c) at repeated intervals less than or equal to the 25 time taken for freshly introduced larvae to mature, adding a fresh quantity of new larvae;

d) when the vat is full, and substantially all the edible matter therein has been consumed by the larvae, removing from the vat the material remaining therein; and
e) drying the removed material.

5 3. A method according to Claim 2, wherein step (e) comprises sterilising the material.

4. A method according to Claim 3, wherein the material is dried and sterilised by the step of heating in an oven.

10 5. A method according to Claim 2, 3 or 4, which comprises adding to the vat at intervals a material capable of absorbing ammonia and/or amines.

15 6. A method according to Claim 5, wherein the absorbent material is selected from chopped straw, paper, cardboard, fuller's earth, zeolites, comminuted brick rubble, comminuted shells and mixtures thereof.

7. A method according to Claim 5 or 6, wherein bulking material is added to the vat at intervals.

8. A method according to Claim 7, wherein the bulking material comprises sand.

9. A method according to any of Claims 2 to 8, wherein additional bulking material is mixed with the removed material.

10. A method according to Claim 9, wherein the additional bulking material is paper or straw.

11. A method according to any preceding claim, wherein the vat comprises at least one wall which slopes outwardly.

12. A method according to Claim 11, wherein two opposed walls of the vat slope outwardly away from each 5 other.

13. A method according to Claim 11 or 12, wherein the or each sloping wall lies in a plane which makes an angle of less than 45° with the horizontal.

14. A method according to Claim 11, 12 or 13, wherein 10 the or each sloping wall is provided with a plurality of grooves in the surface thereof, the grooves extending from the floor of the vat to the uppermost edge of the wall, the base of each groove being inclined to the horizontal at an angle such that mature larvae are induced to ascend the 15 grooves.

15. Apparatus for treating waste animal material, comprising a vat into which the animal material and fly larvae may be introduced, the vat having at least one outwardly sloping wall provided with a plurality of grooves 20 in the surface thereof, the grooves extending from the floor of the vat to the uppermost edge of the wall, the base of each groove being inclined to the horizontal at an angle such that mature larvae are induced to ascend the grooves, and means for collecting the larvae arriving at the uppermost 25 edge of the wall.

16. Apparatus according to Claim 15, wherein the vat is in the form of a channel wherein two opposed channel walls are the said outwardly sloping walls.

5 17. Apparatus according to Claim 16, wherein the vat has a floor extending between said two opposed channel walls.

18. Apparatus according to Claim 15, 16 or 17, wherein the means for collecting the mature larvae comprises a collection channel extending along the length of the or each sloping wall, such that larvae arriving at the uppermost 10 edge of the wall drop into the collection channel, the or each collection channel having at least one collection pit therein, the floor of the channel inclining upwardly towards the mouth of the pit such that the larvae dropping into the collection channel are induced to move themselves upwardly 15 along the floor and into the pit.

19. Apparatus according to Claim 18, wherein suction means are provided for extracting the larvae from the or each collection pit and for delivering the larvae to further processing means.

20 20. Apparatus according to Claim 19, wherein the further processing means comprise thermal sterilisation apparatus.

21. Apparatus according to Claim 19, wherein the further processing means comprise means for packing the 25 larvae for sale as bait.

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22. Apparatus according to any of Claims 15 to 21, comprising means for removing material from the vat, when full.

23. A method of treating waste animal material to 5 form a fertilizer material, comprising introducing at intervals into apparatus according to any of Claims 15 to 22 portions of said material and immature fly larvae, collecting the mature larvae arriving at the uppermost edge of the wall or walls, and, when the vat is full, removing the material 10 remaining therein and drying said material.

24. A method according to Claim 23, wherein the removed material is heat treated to dry and sterilise it.

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FIG. 1.

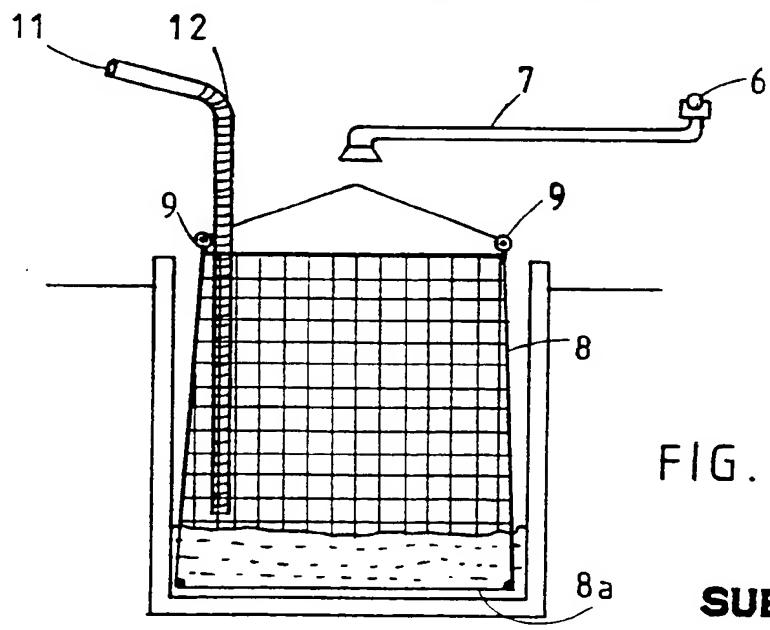
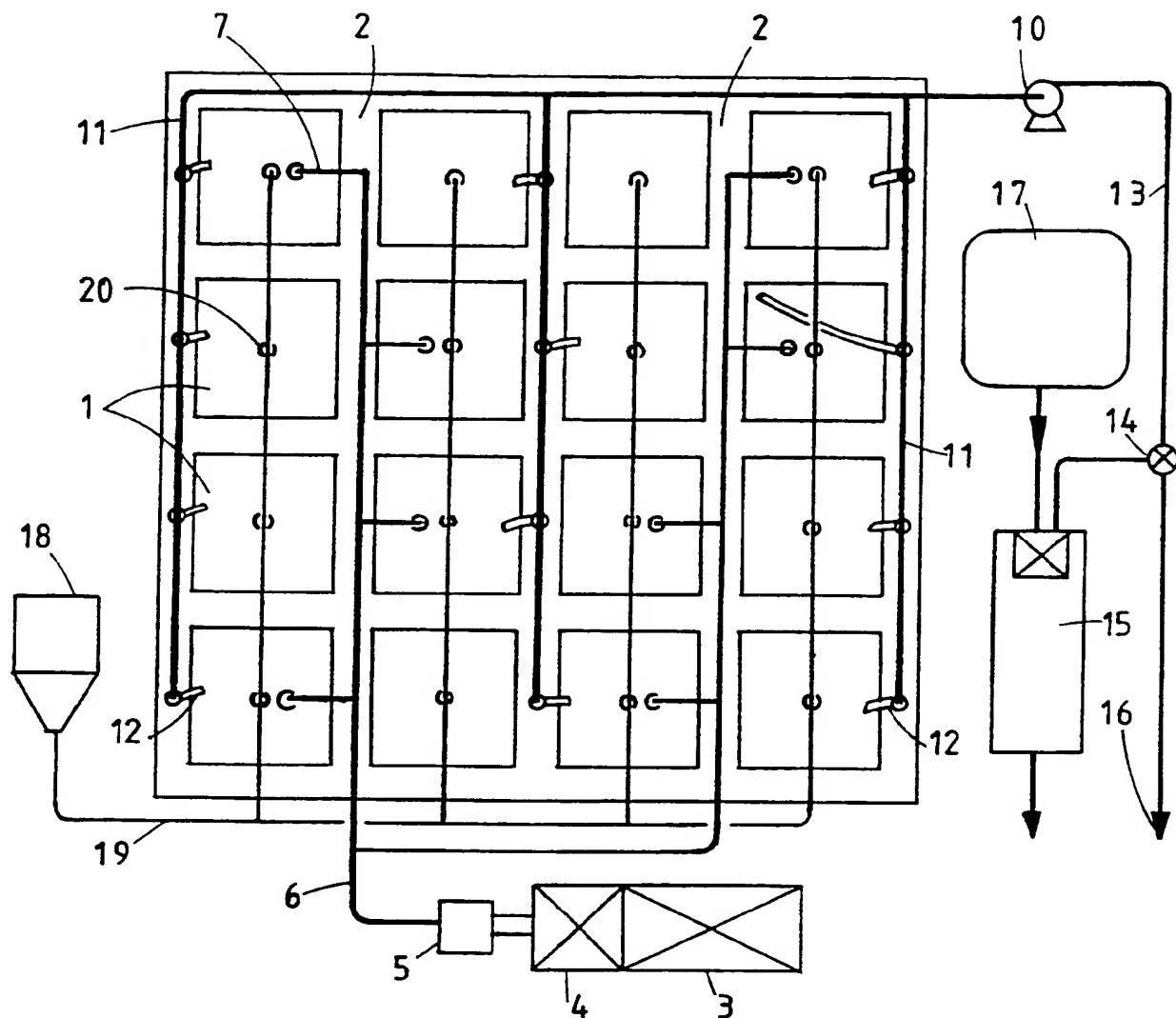
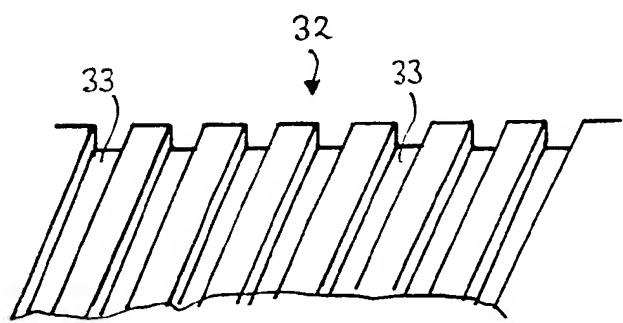
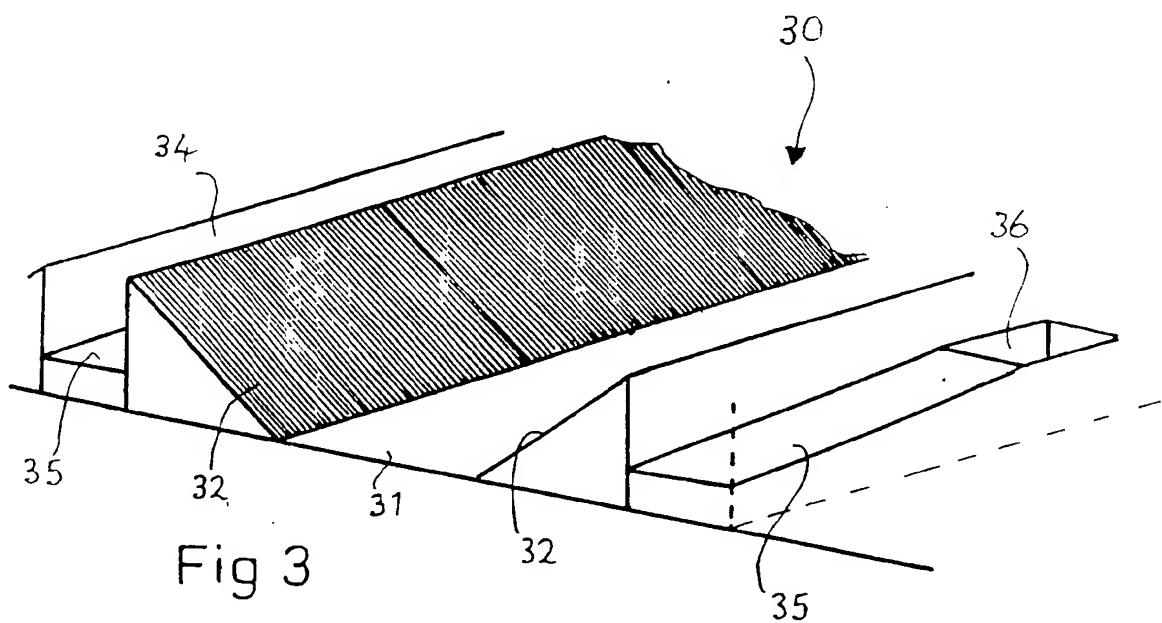


FIG. 2.

SUBSTITUTE SHEET

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3/3

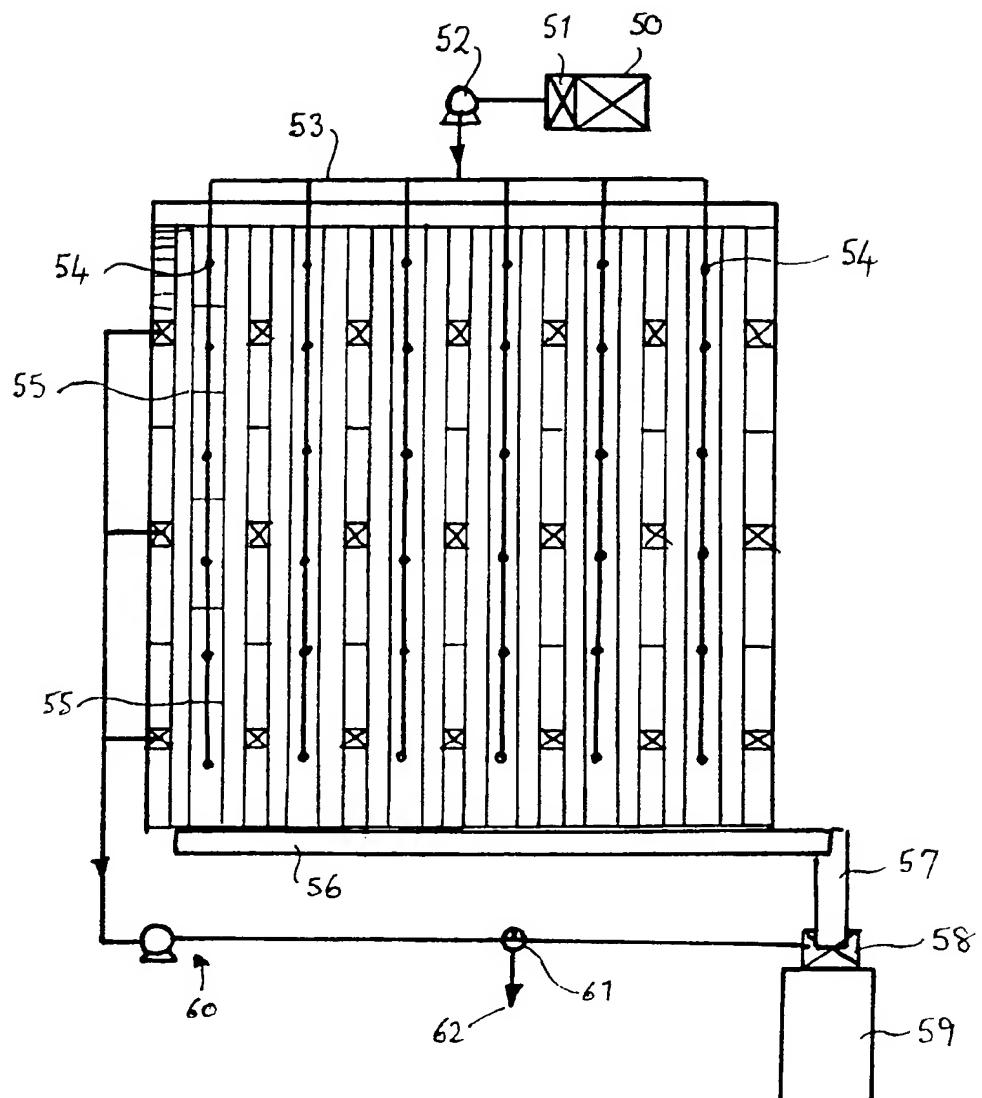


Fig 5

INTERNATIONAL SEARCH REPORT

PCT/GB 91/01067

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)⁶

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.C1. 5 C05F1/00 ; C05F3/00

II. FIELDS SEARCHED

Minimum Documentation Searched⁷

Classification System	Classification Symbols
Int.C1. 5	C05F
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸	

III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹

Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	EP,A,0 365 198 (MAGGOT FARMS) 25 April 1990 see column 1, line 28 - line 48 see column 2, line 26 - column 3, line 21 see column 3, line 51 - column 5, line 13; claims 1-8,10,13,16,17 ---	1-4,15, 20,22-24
A	GB,A,1 502 867 (C. FAYD'HERBE DE MAUDAVE) 8 March 1978 see page 1, line 31 - line 43 see page 2, line 18 - line 48; claim 1 ---	2,5,6
A	EP,A,0 181 153 (BOWATER TECHNICAL SERVICES LMTD) 14 May 1986 see page 1, line 1 - page 5, line 26; claims 1,7 ---	1,5,6

⁶ Special categories of cited documents: ¹⁰^{"A"} document defining the general state of the art which is not considered to be of particular relevance^{"E"} earlier document but published on or after the international filing date^{"L"} document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)^{"O"} document referring to an oral disclosure, use, exhibition or other means^{"P"} document published prior to the international filing date but later than the priority date claimed^{"T"} later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention^{"X"} document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step^{"Y"} document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.^{"A"} document member of the same patent family

IV. CERTIFICATION

V. CLASSIFICATION

Date of the Actual Completion of the International Search

Date of Mailing of this International Search Report

2

04 OCTOBER 1991

23 OCTOBER 1991

International Searching Authority

Signature of Authorized Officer

EUROPEAN PATENT OFFICE

RODRIGUEZ FONTAO M. B. *Japonio Rodriguez*

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.

GB 9101067
SA 49111

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0365198	25-04-90	None	
GB-A-1502867	08-03-78	None	
EP-A-0181153	14-05-86	None	

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